

Form ESA-B4. Summary Report for ESA-140-3

Public Report - Final

Company	United States Steel Corporation	ESA Dates	Aug 11-13, 2008
Plant	Clairton Plant	ESA Type	Pumping Systems
Product	Coke	ESA Specialist	Glenn Cunningham

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction:

The Clairton Plant is located approximately 20 miles south of Pittsburgh in Clairton, Pa., and sits along the west bank of the Monongahela River. The largest coke manufacturing facility in the United States, the Clairton Plant operates 12 coke oven batteries. The Clairton Plant produces approximately 4.7 million tons of coke annually and serves customers in the commercial coke market as well as U. S. Steel's steelmaking facilities.

The pumping assessment focused on two pumping systems: 1) River water supply system; 2) Treated water booster pumps.

Objective of ESA:

To introduce the US DOE PSAT and Valve software tools to plant personnel and use the tools to identify energy saving opportunities related to the plant pumping systems.

Focus of Assessment:

Plant's pumping systems and US DOE pumping software tools.

Approach for ESA:

- Learned PSAT & Valve Tool Software
- Reviewed pumping system fundamentals
- Analyzed 2 Plant Pumping Systems
 - River water Supply pumps
 - Treated water booster pumps
- Proposed several projects for further study
- Measured power, rotational speed and pressures on multiple pumps

General Observations of Potential Opportunities:

- Indicate total plant natural gas consumption for base year, 2007: 824,880 MMBtu
 - Indicate total plant electricity consumption for base year, 2007: 334,926,000 kWh
- ☐ Near Term Opportunities: There were no near term opportunities identified during this assessment.
- ☐ Medium Term Opportunities:

River Water Supply Pumps

There are 6 pumps used to move water from the river to a 145 foot tall stand tank that provides cooling water to the plant. Five of the six pumps have 1,500 hp motors and the sixth pump is "1/2 sized" with a 800 hp motor. The full sized pumps operate at about 21,500 gpm at 184 feet of head (determined from the pump curve and the measured flow rate), depending on the number of pumps in operation. The "1/2 pump" is sized for about 17,500 gpm at 160 feet of head. The stand tank has two headers, east and west, supplying water from these pumps. During much of the summer the cooling water demand from the plant is low enough that two "1/2 pumps" could handle the service. Currently in the summer, during times of reduced flow rates, one large pump operates heavily throttled with a gate valve located at the

pump discharge and the “1/2 sized pump is also used. Based on pressure measurements made during the assessment on the system it is estimated that 68.3 feet of head is being lost across the throttling valve with a flow of 21,500 gpm. The installation of a second “1/2 sized” pump would allow this throttling loss to be eliminated. The current pumping efficiency is estimated at 83.5% and a new pump properly selected should operate with an efficiency close to 93.0%. The PSAT analysis of this recommendation is shown in Figure 1 below. The current condition for the summer operation of one of the large pumps predicts an operating cost of \$247,100 for 6-month at an electrical cost of \$0.060/kWh. Under Condition B, the optimized cost for 6-month operation with a new pump is \$139,300, saving \$107,800 per year. The estimated cost of replacing this pump is about \$100,000, resulting in a simple payback of 0.93 years. The existing 1,500 hp motor could be used to drive the new pump. The motor efficiency does not decline much as load drops until the load is reduced to below 35% or so. Power factor correction capacitors should be considered for addition to the motor as operating a motor at 50% load will cause the power factor to decline significantly from its full load value.

Pumping System Assessment Tool

File Tools Help

PSAT 2008

Condition A			Condition B					
Double section	Double section		Existing	Optimal	Units	Existing	Optimal	Units
Pump rpm: 714	Pump rpm: 714		Pump efficiency: 83.5	92.6	%	45.6	92.8	%
Drive: Direct drive	Drive: Direct drive		Motor rated power: 1500	1250	hp	1500	700	hp
Units: gpm, ft, hp	Units: gpm, ft, hp		Motor shaft power: 1196.7	1077.9	hp	1379.6	677.4	hp
Kinematic viscosity (cS): 1.00	Kinematic viscosity (cS): 1.00		Pump shaft power: 1196.7	1077.9	hp	1379.6	677.4	hp
Specific gravity: 1.000	Specific gravity: 1.000		Motor efficiency: 95.0	95.4	%	94.9	95.3	%
# stages: 1	# stages: 1		Motor power factor: 75.4	76.5	%	77.6	77.2	%
Fixed specific speed? YES	Fixed specific speed? YES		Motor current: 300.0	265.1	amps	336.4	165.2	amps
Line freq: 60 Hz	Line freq: 60 Hz		Motor power: 940.1	842.9	kW	1085.0	530.1	kW
HP: 1500	HP: 1500		Annual energy: 4117.5	3692.0	MWh	4752.3	2321.9	MWh
Motor rpm: 714	Motor rpm: 714		Annual cost: 247.1	221.5	\$1000	285.1	139.3	\$1000
Eff. class: Average	Eff. class: Average							
Voltage: 2400	Voltage: 2400		Annual savings potential, \$1,000	25.5		145.8		
Estimate FLA	Estimate FLA		Optimization rating, %	89.7		43.9		
Full-load amps: 361.3	Full-load amps: 361.3							
Size margin, %: 0	Size margin, %: 0							
Operating fraction: 0.500	Operating fraction: 0.500							
\$/kwhr: 0.0600	\$/kwhr: 0.0600							
Flow rate, gpm: 21500	Flow rate, gpm: 21500							
Head tool: Head, ft: 184	Head tool: Head, ft: 116							
Load estim. method: Current	Load estim. method: Power							
Motor amps: 300.0	Motor kW: 1085.0							
Voltage: 2400	Voltage: 2400							

Log file controls: Create new log, Add to existing log, Retrieve log entry, Delete log entry

Summary file controls: Create new summary file, Existing summary files, CREATE NEW

Condition A Notes: Facility, System, Date, Application, Evaluator, General comments: #5 pump optimized for 1/2 pump

Condition B Notes: Facility, System, Date, Application, Evaluator, General comments

Retrieve defaults, Set defaults, Copy A > to B >, Copy B < to A <, Background information, STOP

System curve tool: select below

Figure 1. PSAT Analysis for Replacing Large River Water Pump

The pump and system curves are shown below in Figure 2.

P-5 River Water Pump

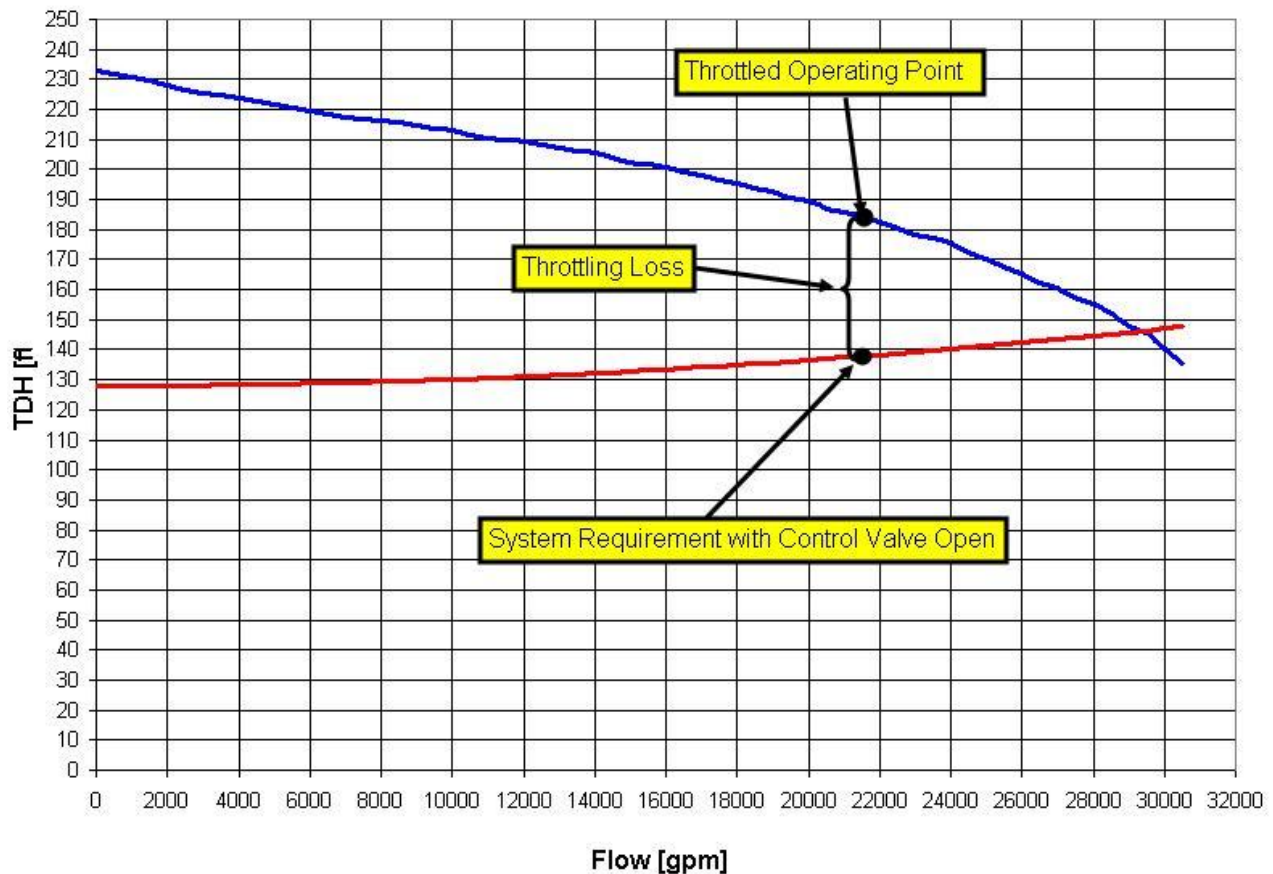


Figure 2. Pump and System Curve for Pump #5

Treated Water Booster Pumps:

The treated water booster pump system is comprised of 4 identical pumps, two with electric motors and two powered with steam turbine drives. Normal operation has two pumps in use, one motor driven and the other with a steam turbine drive. The pumps are operating in a heavily throttled condition causing poor pumping efficiency. Each pump is rated for 3,000 gpm at 160 feet of head. Two pumps are operated to assure adequate flows to the steam system should one pump fail. Required flow rates range from about 1,800 gpm to 2,930 gpm. With this range of flow rates it should be possible to operate just one pump and reduce the throttling losses across the control valves. Not only will energy be saved, but maintenance costs for the control valves and pumps will be reduced. It is reported that cavitation sometimes occurs at the discharge side of the control valves. When this condition exists the pressure drop across the control valve will be larger than expected and the valve will be damaged.

The recommended condition is to operate just one of the turbine driven pumps and install controls to automatically start a motor driven pump if additional flow is needed. These controls can monitor the water level in the deaerator as well as pressures in the pumping system to determine when an additional pump is needed.

Pumping System Assessment Tool

File Tools Help

PSAT 2008

Condition A

Double suction

Pump rpm: 1775

Drive: Direct drive

Units: gpm, ft, hp

Kinematic viscosity (cS): 1.00

Specific gravity: 1.000

stages: 1

Fixed specific speed? YES

Line freq: 60 Hz

HP: 150

Motor rpm: 1765

Eff. class: Average

Voltage: 440

Estimate FLA

Full-load amps: 175.0

Size margin, %: 0

Operating fraction: 1.000

\$/kwhr: 0.0600

Flow rate, gpm: 1014

Head tool: Head, ft: 170

Load estim. method: Current

Motor amps: 100.0

Voltage: 468

Retrieve defaults Set defaults Copy A > to B >

System curve tool: select below

Condition B

Double suction

Pump rpm: 1775

Drive: Direct drive

Units: gpm, ft, hp

Kinematic viscosity (cS): 1.00

Specific gravity: 1.000

stages: 1

Fixed specific speed? YES

Line freq: 60 Hz

HP: 150

Motor rpm: 1765

Eff. class: Average

Voltage: 440

Estimate FLA

Full-load amps: 175.0

Size margin, %: 0

Operating fraction: 1.000

\$/kwhr: 0.0600

Flow rate, gpm: 1014

Head tool: Head, ft: 130

Load estim. method: Current

Motor amps: 100.0

Voltage: 468

Copy B < to A < Background information STOP

	Condition A		Units	Condition B		Units
	Existing	Optimal		Existing	Optimal	
Pump efficiency	55.8	86.0	%	42.7	87.2	%
Motor rated power	150	60	hp	150	40	hp
Motor shaft power	77.9	50.6	hp	77.9	38.2	hp
Pump shaft power	77.9	50.6	hp	77.9	38.2	hp
Motor efficiency	93.7	94.4	%	93.7	93.6	%
Motor power factor	76.5	83.5	%	76.5	84.8	%
Motor current	100.0	59.1	amps	100.0	44.3	amps
Motor power	62.0	40.0	kW	62.0	30.4	kW
Annual energy	543.4	350.3	MWh	543.4	266.4	MWh
Annual cost	32.6	21.0	\$1000	32.6	16.0	\$1000
Annual savings potential, \$1,000		11.6			16.6	
Optimization rating, %		64.5			49.0	

Log file controls:

Create new log Add to existing log

Retrieve log entry Delete log entry

Summary file controls:

Create new summary file

Existing summary files

CREATE NEW

Condition A Notes

Facility: System: Date:

Application: Evaluator:

General comments:

TWP with collected data

Condition B Notes

Facility: System: Date:

Application: Evaluator:

General comments:

#5 pump optimized for 1/2 pump

Figure 3. PSAT Model of One Electric Motor Driven Treated Water Booster Pump

The throttling loss across the valve can be evaluated with knowledge of the valve characteristics and the Valve Tool provided with the PSAT program. Information relating valve size, position and flow rate was obtained from Don Casada for the Fisher V150 ball valve used in this application for flow control. After obtaining a valve C_v of 490 for a 10" valve 50% open with a flow of 1,010 gpm, the Valve Tool was used to show the value of the energy dissipated across the valve. The curve of valve C_v versus position is shown in Figure 4 below and the Valve Tool analysis is shown in Figure 5.

The calculated savings for changing to the operation to a single steam driven pump instead of two pumps operating heavily throttled are \$31,820 annually. The estimated cost is \$30,000, giving a simple payback of 0.94 years.

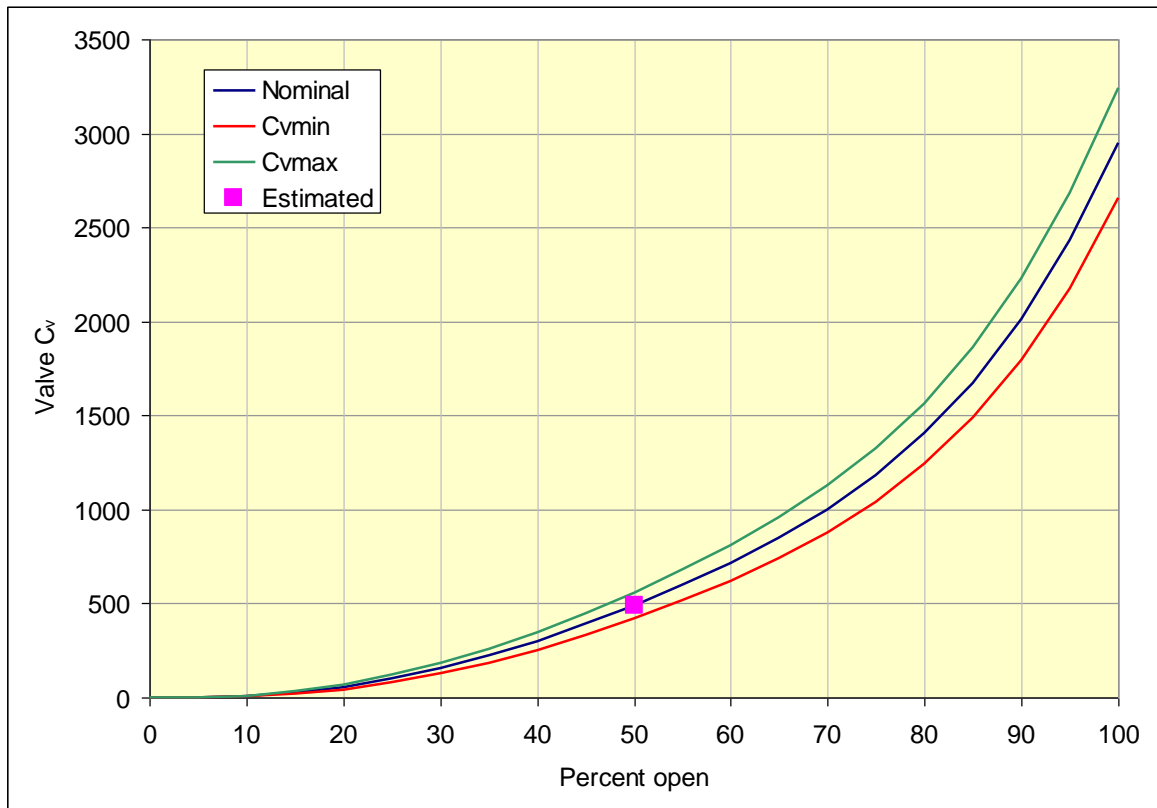


Figure 4. Fisher V150 Control Valve C_v versus Valve Position

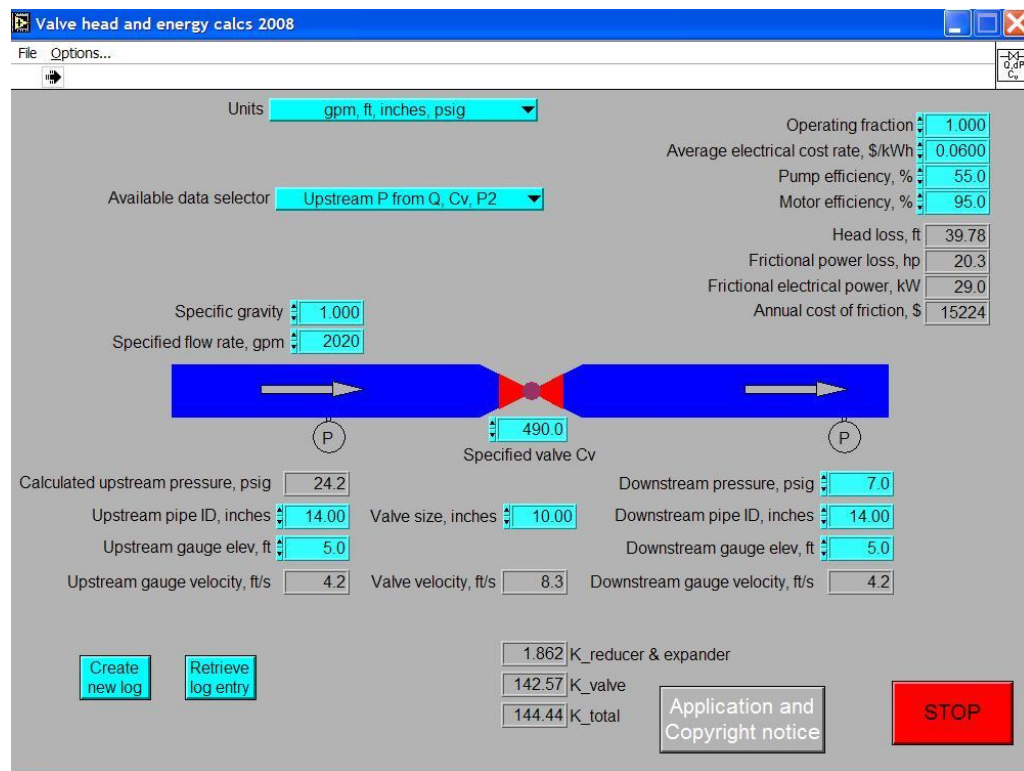


Figure 5. Valve Tool Analysis of Energy Loss Across Fisher V150 Control Valve

❑ There were no long term opportunities identified during this assessment.

- Estimate, if possible, the identified % plant fuel savings from a) Near Term opportunities: 0%; b) Medium Term opportunities: -0.069%, c) Long Term opportunities: 0%.
- Estimate, if possible, the identified % electricity savings from a) Near Term opportunities: 0%; b) Medium Term opportunities: 0.729%; c) Long Term opportunities: 0%.

Management Support and Comments:

Plant and corporate management is very committed to improving the energy efficiency of this facility. Staff preparation for the Pumping Assessment was excellent, with PSAT software downloaded and explored prior to the assessment.

DOE Contact at Plant/Company:

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